

WHAT IS CLAIMED IS:

1. A method of applying electrical energy to an electrostatic precipitator collector which optimizes precipitation of high resistivity particulates from a gas stream, comprising the steps of:

selecting an initial time interval for application of electrical energy having a first electrical polarity to said electrostatic precipitator collector and an initial time interval for interrupting said application of electrical energy;

determining optimum amounts of time for said application of electrical energy and said interrupting of said application based upon the greatest peak voltage magnitude applied and greatest average voltage magnitude applied; and

collecting precipitate on said electrostatic precipitator collector using said optimum amounts of time for said application of electrical energy and said interrupting of said application.

2. The method of applying electrical energy to an electrostatic precipitator collector of claim 1, further comprising the steps of:

measuring a time interval of said collecting step;

re-establishing optimum amounts of time for said application of electrical energy and said interrupting of said application based upon the greatest peak voltage magnitude applied and greatest average voltage magnitude applied responsive to said measured time interval of said collecting step exceeding a threshold; and

resetting said measured time interval.

3. The method of applying electrical energy to an electrostatic precipitator collector of claim 1, wherein said selecting step further comprises the steps of:

establishing an amount of time required for said high frequency direct current power supply to charge said electrostatic precipitator from an electrical potential magnitude representative of some fraction of an onset of corona to an electrical potential magnitude representative of some fraction of a spark; and

setting said initial time interval for application of electrical energy equal to said established time.

4. The method of applying electrical energy to an electrostatic precipitator collector of claim 1, wherein said selecting step further comprises the steps of:

establishing an amount of time required for said electrostatic precipitator to discharge from an electrical potential magnitude representative of a spark to an electrical potential magnitude representative of an onset of corona; and

setting said initial time interval for interrupting said application of electrical energy equal to said established time.

5. The method of applying electrical energy to an electrostatic precipitator collector of claim 1, wherein said determining step is performed iteratively.

6. The method of applying electrical energy to an electrostatic precipitator collector of claim 5, wherein said iterative determining step further comprises the steps of:

specifying an active time interval for interrupting said application of electrical energy to equal said initial time interval for interrupting said application of electrical energy;

assigning an active time interval for application of electrical energy to equal said initial time interval for application of electrical energy;

alternately energizing said electrostatic precipitator for said active time interval for application of electrical energy and de-energizing said electrostatic precipitator for said active time interval for interrupting said application and decreasing said active time interval for interrupting said application of electrical energy during each subsequent active time interval for interrupting said application of electrical energy; and

storing peak and average values of an electrical potential attained at said electrostatic precipitator.

7. The method of applying electrical energy to an electrostatic precipitator collector of claim 6, wherein said iterative determining step further comprises the steps of:

decreasing said active time interval for interrupting said application; and

repeating said steps of alternately energizing and storing.

8. An electrostatic precipitator performance optimization control method for optimizing the performance of an electrostatic precipitator using a high frequency direct current power supply and processing moderate to high resistivity particulate gas streams such as are produced during the combustion of low-sulfur coal in electric utility plants, comprising the steps of:

establishing an initial on time interval for applying energy from said high frequency direct current power supply to said electrostatic precipitator comparable to an amount of time required for said high frequency direct current power supply to charge said electrostatic precipitator from an electrical potential magnitude representative of an onset of corona to an electrical potential magnitude representative of a spark;

determining an initial off time interval for disconnecting energy from said high frequency direct current power supply to said electrostatic precipitator comparable to an amount of time required for said electrostatic precipitator to discharge from an electrical potential magnitude representative of a spark to an electrical potential magnitude representative of an onset of corona;

specifying an active off time interval to approximately equal said initial off time interval;

assigning an active on time interval to approximately equal to said initial on time interval;

alternately energizing said electrostatic precipitator for said active on time interval and de-energizing said electrostatic precipitator for said active off time interval and decreasing said active off time interval during each subsequent active on time energizing interval;

storing peak and average values of an electrical potential attained at said electrostatic precipitator;

decreasing said active off time interval;

repeating said steps of alternately energizing and storing;

setting said active on time interval and said active off time interval to a maximum of said peak and average values of said electrical potential attained at said electrostatic precipitator; and operating said electrostatic precipitator by alternately energizing said electrostatic precipitator for said active on time interval and de-energizing said electrostatic precipitator for said active off time interval.

9. The electrostatic precipitator performance optimization control method of claim 8 wherein said setting step further comprises applying values to said active on time interval and said active off time interval that were stored with a maximum of said peak and average values of said electrical potential stored in said storing step.

10. The electrostatic precipitator performance optimization control method of claim 8 wherein said setting step further comprises applying values to said active on time interval and said active off time interval that are calculated from maximums of said peak and average values of said electrical potential stored in said storing step.

11. The electrostatic precipitator performance optimization control method of claim 10 further comprising the steps of:

operating said electrostatic precipitator using said active on time interval and said active off time interval for a plurality of cycles;

testing at least one of said spark voltage, said peak value of said electrical potential, and said average value of said electrical potential.

12. The electrostatic precipitator performance optimization control method of claim 8 further comprising the steps of:

deciding whether the stored peak and average values of an electrical potential attained at said electrostatic precipitator increase as said active off time interval decreases; and

responsive to an affirmative decision in said deciding step:

decreasing said active off time interval; and

re-executing said assigning, alternately energizing, storing, decreasing, repeating, and setting steps.

13. The electrostatic precipitator performance optimization control method of claim 8 further comprising the step of re-executing said establishing, determining, specifying, assigning, alternately energizing, storing, decreasing, repeating, setting and operating steps after a predetermined time of operation has elapsed.

14. An electrostatic precipitator having at least one discharge electrode for charging high resistivity particulates within a gas stream, at least one collector for attracting said charged particulates within said gas stream, a high voltage power source operatively and selectively able to apply a high voltage potential of a first polarity between said at least one discharge electrode and said at least one collector, and a means for operatively switching said high voltage power source high voltage potential into and out of electrical conduction to said at least one discharge electrode and said at least one collector, wherein the improvement comprises:

- a means for approximating a maximum peak voltage and maximum average voltage applied to said at least one discharge electrode and said at least one collector when a duty cycle of said switching means is varied;
 - a means for storing a duty cycle associated with said maximums; and
 - a means for controlling said switching means to reproduce said stored duty cycle repetitively.
15. The electrostatic precipitator of claim 14 further comprising:
- a means to measure a cumulative time of said switching means reproducing said stored duty cycle; and
 - a means to re-initiate said approximating, storing and controlling means when said measuring means exceeds a predetermined cumulative time.
16. The electrostatic precipitator of claim 14 wherein said high resistivity particulates within said gas stream are the effluent from a low-sulfur coal-fired utility.
17. The electrostatic precipitator of claim 16 wherein said particulates comprise fly ash.
18. The electrostatic precipitator of claim 17 wherein said duty cycle of said switching means is approximately twenty-two milliseconds.
19. The electrostatic precipitator of claim 18 wherein said high voltage potential of said high voltage power source is between 5,000 and 150,000 volts.

20. In combination with a coal-fired electric utility plant discharging fly ash into the atmosphere, a gas separation apparatus for optimally removing the fly ash from the plant, comprising an electrostatic precipitator (ESP), a power supply for the ESP, the power supply having a pulse width modulated to maximize the peak electric field and average electric field.
21. The method of optimally operating an electrostatic precipitator in a gas separation apparatus, comprising the steps of providing an electrostatic precipitator (ESP) powered by a DC power supply, modulating the pulse width of the DC power supply to maximize the peak electric field and the average electric field of the ESP, selecting initial "on" and "off" times, respectively, for the DC power supply, and operating the DC power supply using the initial "off" time and initial "on" time.
22. In the method of operating an electrostatic precipitator in a gas separation apparatus, the improvement which comprises the step of maximizing the scalar product of the peak voltage and the average voltage for optimal operation of the electrostatic precipitator,